



88136003

**BIOLOGY**
HIGHER LEVEL
PAPER 3

Candidate session number

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Thursday 14 November 2013 (morning)

Examination code

1 hour 15 minutes

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INSTRUCTIONS TO CANDIDATES

- Write your session number in the boxes above.
- Do not open this examination paper until instructed to do so.
- Answer all of the questions from two of the Options.
- Write your answers in the boxes provided.
- A calculator is required for this paper.
- The maximum mark for this examination paper is [40 marks].

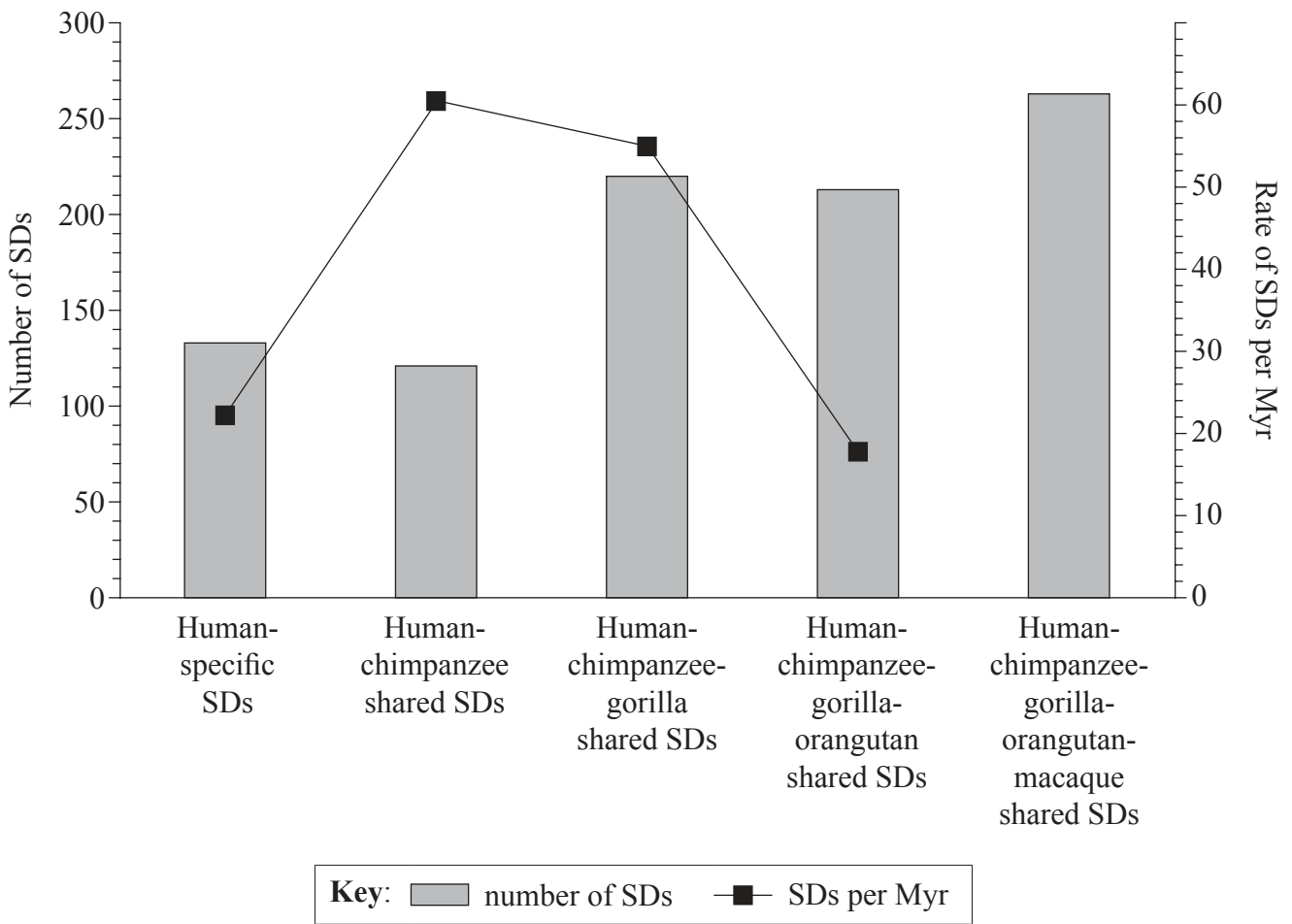
Option	Questions
Option D — Evolution	1 – 3
Option E — Neurobiology and behaviour	4 – 6
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Option G — Ecology and conservation	10 – 12
Option H — Further human physiology	13 – 15



28EP01

Option D — Evolution

- 1. Analysis of the genome of primates reveals many DNA segments that have been duplicated. It is possible to deduce the stage in evolution at which segmental duplications (SDs) occurred by comparing human and other primate genomes. Human-specific SDs occurred after humans and chimpanzees diverged. Human-chimpanzee shared SDs occurred after the common human-chimpanzee ancestor diverged from gorillas and so on. It is possible to estimate the rates at which SDs occurred during evolution using knowledge of when the primates changed. In the chart the bars indicate numbers of shared SDs and the line shows estimates of the rate of SDs per millions of years (Myr).



[Source: Reprinted by permission from Macmillan Publishers Ltd: Tomas Marques-Bonet, Jeffrey M. Kidd, Mario Ventura, Tina A. Graves and Ze Cheng et al. (2009) 'A burst of segmental duplications in the genome of the African great ape ancestor.' *Nature*, 457, pp. 877–881.]

- (a) (i) State the number of SDs that can be found in humans but not in other primates. [1]

(Option D continues on the following page)



28EP02

(Option D, question 1 continued)

- (ii) State the rate of SDs after the divergence of macaques from the other primates, giving the units. [1]

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- (b) Outline the trends in the rate of SDs occurring since the separation of orangutans from other primates. [2]

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- (c) Explain how the number of human-chimpanzee shared SDs can be the lowest despite the rate of SDs per millions of years being the highest. [2]

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- (d) A few SDs were found in humans and gorillas but not chimpanzees. Suggest how this might have occurred. [1]

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(Option D continues on the following page)



28EP03

Turn over

(Option D, question 1 continued)

(e) Design a cladogram showing the divergence of humans and primates.

[1]

2. Cystic fibrosis (CF) is caused by a mutation of a human gene which codes for a chloride channel. The frequency of the CF allele is much higher in Europe than expected for an allele that causes a harmful condition. It has been suggested that individuals who are heterozygous for this allele may be protected against an infectious disease such as cholera or typhoid. This could cause both the CF allele and the normal allele of the chloride channel gene to persist in the population.

(a) State the name given to the situation where two alleles of a gene persist indefinitely in a population.

[1]

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(Option D continues on the following page)



(Option D, question 2 continued)

- (b) CF is a recessive condition that affects approximately 1 in 2500 births in Australia. Calculate the percentage of heterozygous individuals in the population. Show your calculation. [2]

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- (c) Using CF as an example, distinguish between *allele frequency* and *gene pool*. [2]

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- (d) State **one** condition that must be fulfilled if the allele frequency for CF is to remain constant. [1]

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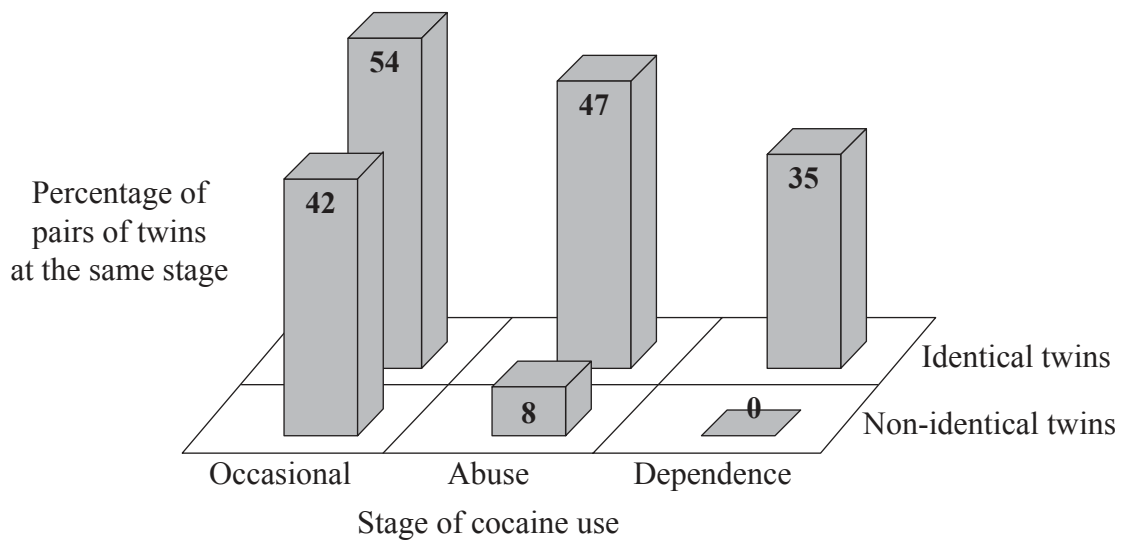


28EP07

Turn over

Option E — Neurobiology and behaviour

4. A study was conducted into the influence of genetic factors on occasional cocaine use, abuse and dependency. Pairs of female twins were interviewed to determine if either or both of them had used cocaine at all and also whether they had become abusers of cocaine or dependent upon it. Abuse was diagnosed if cocaine was having harmful consequences on the life of the person and dependence by signs that the person would suffer withdrawal symptoms without it. For each of these three stages of cocaine use, concordance rates were calculated for both identical and non-identical twins. The concordance rate is how many pairs of twins are both at a particular stage, expressed as a percentage of the total number of pairs in which either or both are at that stage. The bar chart shows the results.



[Source: adapted from P Zickler, (1999), *NIDA Notes*, 14, number 4]

(a) Identify which stage of cocaine use shows the least percentage difference between identical twins and non-identical twins. [1]

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(Option E continues on the following page)



(Option E, question 4 continued)

- (b) Compare the results for identical twins and non-identical twins. [3]

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- (c) Analyse the data to find whether it supports the hypothesis that genetic factors cause some people to have a much higher chance of cocaine dependence than others. [3]

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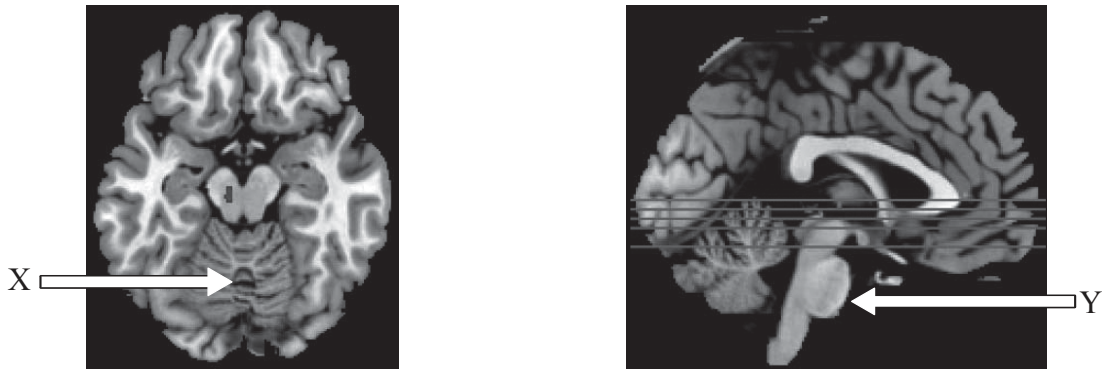


28EP09

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(Option E continued)

5. The following images identify brain activity associated with a specific function.



[Source: SfN Article: Gambling Severity Predicts Midbrain Response to Near-Miss Outcomes, Henry W. Chase and Luke Clark, Articles – Behavioral/Systems/Cognitive | *The Journal of Neuroscience*, 5 May 2010, **30(18)**: 6180–6187; doi:10.1523/JNEUROSCI.5758-09.2010]

(a) Label the indicated areas on the images. [1]

X:

Y:

(b) State the diagnostic tool used for functional analysis in the images. [1]

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(c) Using the table below, distinguish between *rod cells* and *cone cells*. [3]

Characteristic	Rod cells	Cone cells
Location		
Light intensity detected		
Connection to optic nerve		

(Option E continues on the following page)



(Option E, question 5 continued)

- (d) Outline the challenges in controlling experiments involving human behaviour. [2]

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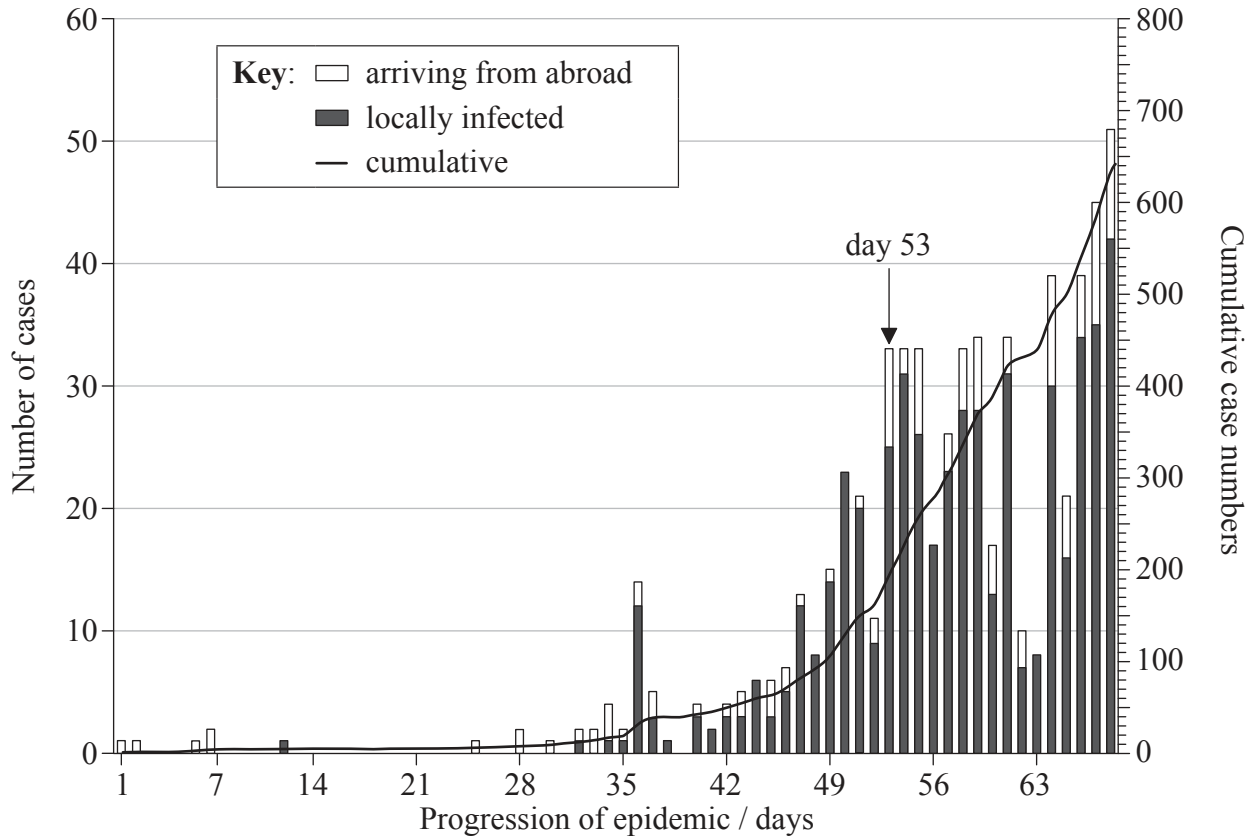


28EP13

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Option F — Microbes and biotechnology

7. Swine flu was identified as a new influenza strain in Mexico in April 2009. The first case diagnosed in Israel arrived from abroad on 26 April 2009 (day 1). The graph shows the progression of the epidemic in Israel.



[Source: adapted from Uri Roll, Rami Yaari, Guy Katriel, Oren Barnea, Lewi Stone, Ella Mendelson, Michal Mandelboim and Amit Huppert (2011) 'Onset of a pandemic: characterizing the initial phase of the swine flu (H1N1) epidemic in Israel.' *BMC Infectious Diseases*, **11**, p. 92.]

- (a) State the day the first locally infected case was identified. [1]

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- (b) State the cumulative number of cases at 56 days. [1]

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(Option F continues on the following page)



28EP14

(Option F, question 7 continued)

- (c) At day 53, visiting students from abroad were confirmed to have Swine flu. Calculate the increase in locally infected cases between day 53 and 54. [1]

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- (d) (i) Outline the progression in the number of cases of Swine flu due to local infection in Israel. [2]

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- (ii) Suggest a reason for the long delay between the first and the second locally infected cases. [1]

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(Option F continues on the following page)



28EP15

Turn over

(Option F, question 7 continued)

- (e) Discuss the typical features of pandemics that are shown by this example. [3]

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8. (a) Explain the use of acids for food conservation. [2]

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- (b) Using the table below, state the organisms involved in the following processes. [2]

Process	Organism
Wine production	
Nitrogen fixation	

- (c) Define *chemoheterotroph*. [1]

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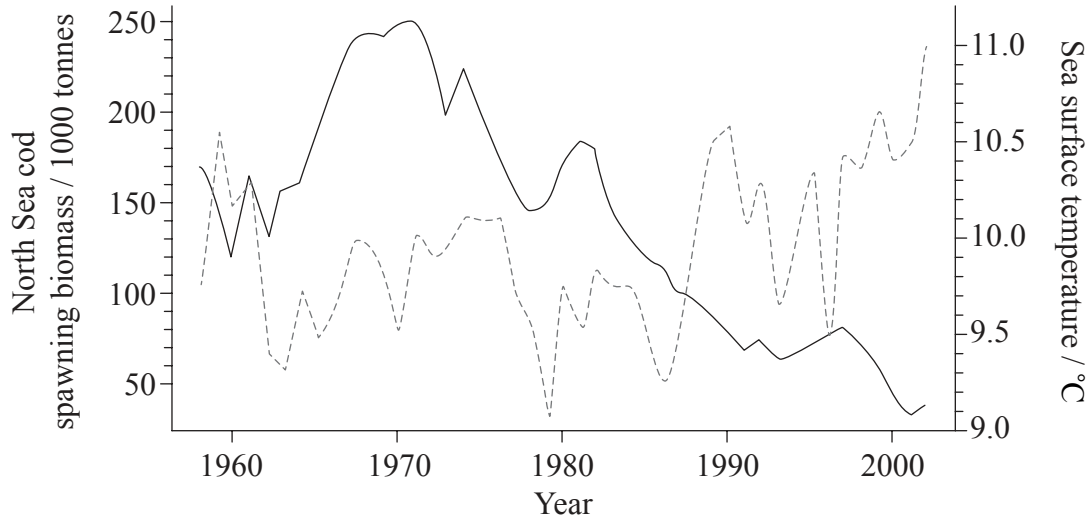
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Option G — Ecology and conservation

10. Reproduction in fish is called spawning. The males and females in a population that are mature enough to reproduce are the spawning stock. In order to provide better fisheries management and conservation decisions, there is a need to investigate the relationship between spawning stock and environmental conditions. The graph shows the North Sea cod spawning biomass and sea surface temperatures.



Key: — spawning --- temperature

[Source: adapted from EM Olsen, *et al.*, (2011), *Proceedings of the Royal Society B*, **278** (1705), pp. 504–510. Figs 1 (a) and 1 (b).]

(a) (i) State the sea surface temperature when the North Sea cod spawning biomass was the highest, giving the units. [1]

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(ii) State the North Sea cod spawning biomass when the sea surface temperature was the lowest, giving the units. [1]

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(Option G continues on the following page)



(Option G, question 10 continued)

- (b) Outline the trends in North Sea cod spawning biomass between 1960 and 2000. [2]

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- (c) Evaluate the evidence provided by the data, for the prediction that North Sea cod will become extinct if sea temperatures continue to rise. [3]

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- (d) Suggest **one** factor, other than sea surface temperature, that might influence the North Sea Cod spawning biomass. [1]

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(Option G continues on the following page)



28EP19

Turn over

(Option G continued)

11. (a) Define *biomass*. [1]

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(b) (i) State the type of ecological change that will occur following the formation of an island from cooled lava in the Pacific Ocean. [1]

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(ii) Outline the ecological changes that will occur on the island of cooled lava. [4]

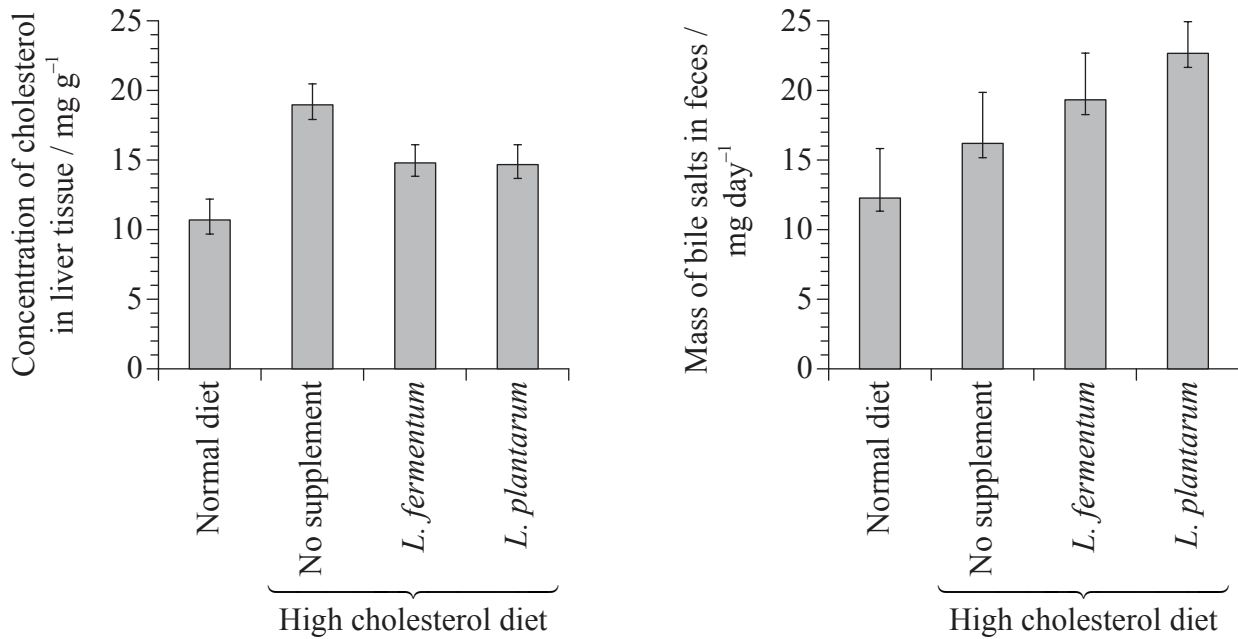
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Option H — Further human physiology

13. The cholesterol-lowering effect of *Lactobacillus* bacteria was studied. Forty rats were divided into groups and fed either a normal or high cholesterol diet. Some rats fed the high cholesterol diet were also supplemented with *L. fermentum* or *L. plantarum*. After a six week feeding period, the concentration of cholesterol in liver tissue and the mass of bile salts in feces were measured.



[Source: adapted from Ning Xie, Yi Cui, Ya-Ni Yin, Xin Zhao, Jun-Wen Yang, Zheng-Gen Wang, Nian Fu, Yong Tang, Xue-Hong Wang, Xiao-Wei Liu, Chun-Lian Wang, Fang-Gen Lu (2011) Effects of two *Lactobacillus* strains on lipid metabolism and intestinal microflora in rats fed a high-cholesterol diet. *BMC Complementary and Alternative Medicine*, **11**, pp. 53–64.]

(a) State the concentration of cholesterol in liver tissue and the mass of bile salts in feces for the normal diet, giving the units. [2]

Concentration of cholesterol:

Mass of bile salts:

(Option H continues on the following page)



(Option H, question 13 continued)

- (b) Calculate the percentage increase in the concentration of cholesterol in liver tissue, caused by feeding the rats a high cholesterol diet without supplementing with bacteria. Show your workings. [1]

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- (c) Deduce the effects of supplementing the diet with *Lactobacillus* on the concentration of cholesterol in liver tissue and on the mass of bile salts in feces. [2]

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- (d) Scientists hypothesized that *Lactobacillus* could be used in diets to reduce the incidence of coronary heart disease (CHD). Evaluate the evidence for and against this hypothesis provided by the data. [3]

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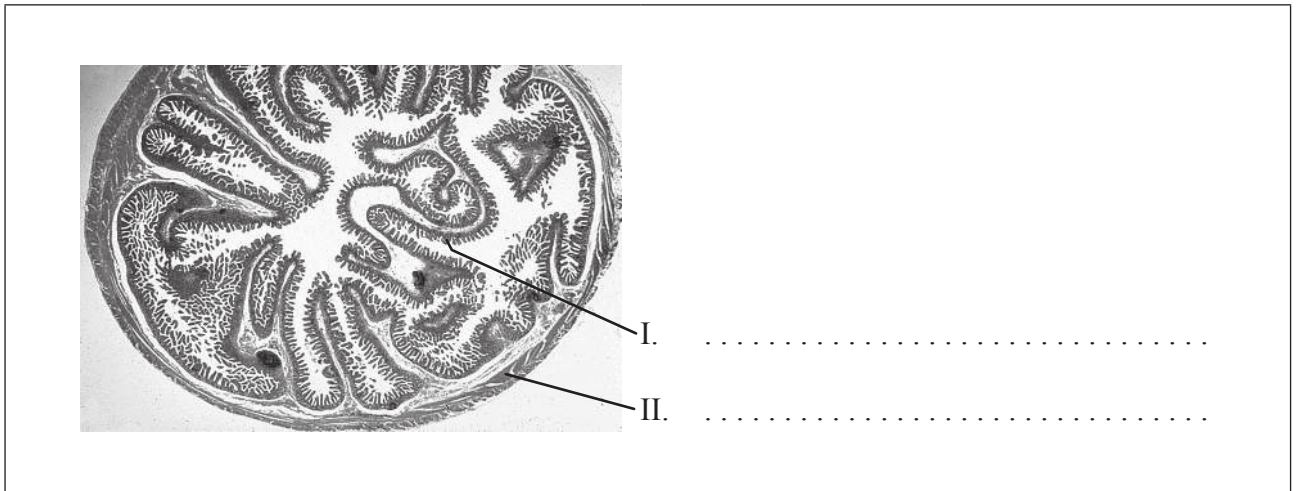


28EP23

Turn over

(Option H continued)

14. (a) Label the indicated structures on the micrograph of a transverse section of an ileum. [1]



[Source: www.udel.edu/biology/Wags/histopage/colorpage/csi/csipts.gif. Used with permission]

- (b) Outline a mechanism used to transport products of digestion from the lumen of the ileum into the blood. [3]

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- (c) Outline the role of membrane-bound enzymes in digestion. [2]

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28EP28